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JLTV – Briefings to Industry

Ground Vehicle Power and Mobility (GVPM)

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Agenda

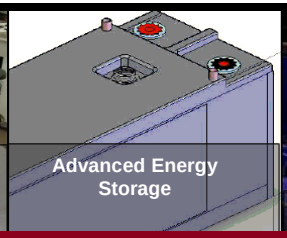
- GVPM - Overview
- Magneto-Rheological Suspension
- Commercial Engine Optimization
- Duel Voltage Integrated Starter Generator Development
- Silicon Carbide Power Electronics
- Advanced Battery Efforts
- Advanced Heat Exchangers
- Power and Thermal Management Efforts
- TARDEC Testing Capabilities

GVPM - Mission and Vision

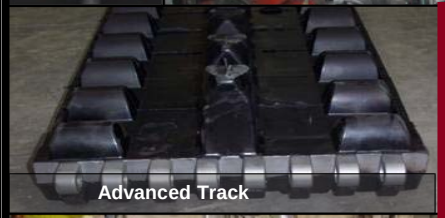

JP-8 Reformer


Engine Testing

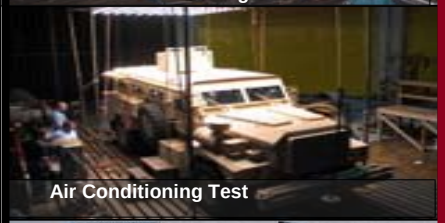

Air Cleaner Testing


Advanced Energy Storage


Power and Energy SIL


Advanced Track


Transmission Testing


Air Conditioning Test

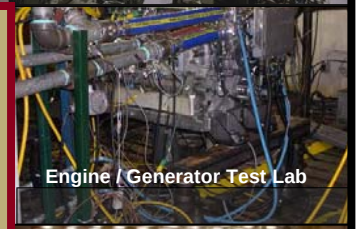

Auxiliary Power Units


Engine Research

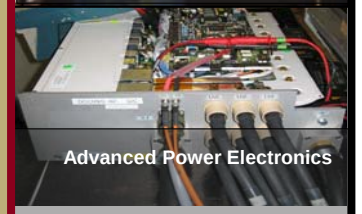

Integrated Power and Thermal Systems

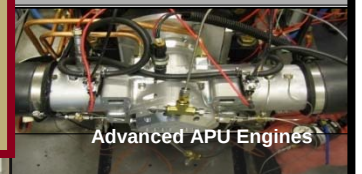

APU Testing & Analysis


Elastomer Research


Engine / Generator Test Lab


Full Load Cooling Test


Advanced Power Electronics


Advanced APU Engines


Energy Storage

VISION:

Be the Army's "Center of Excellence" for technology and engineering expertise for research, development, testing and engineering of ground vehicle power and mobility technologies – today and tomorrow.

MISSION:

Provide technically sound and timely responses to the soldiers' current and future needs for technology and engineering expertise in ground vehicle power and mobility technologies.

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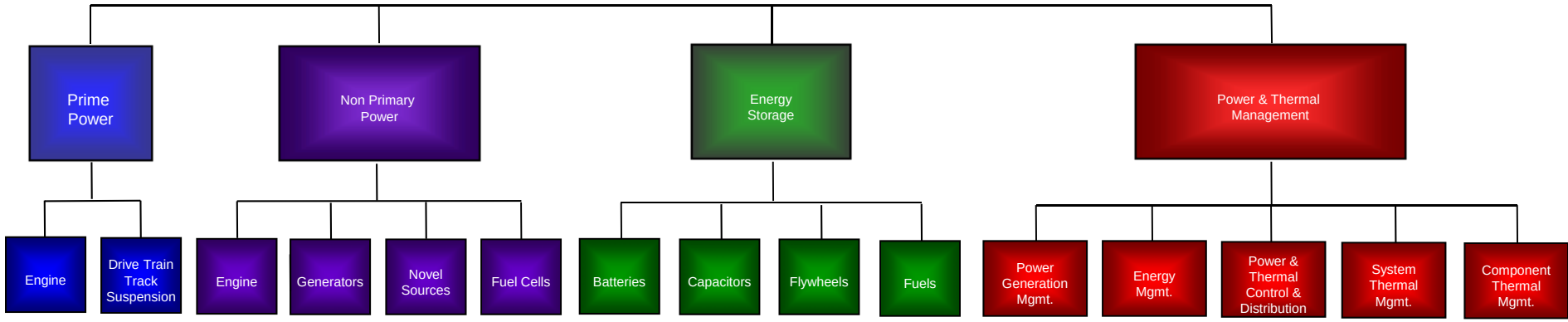
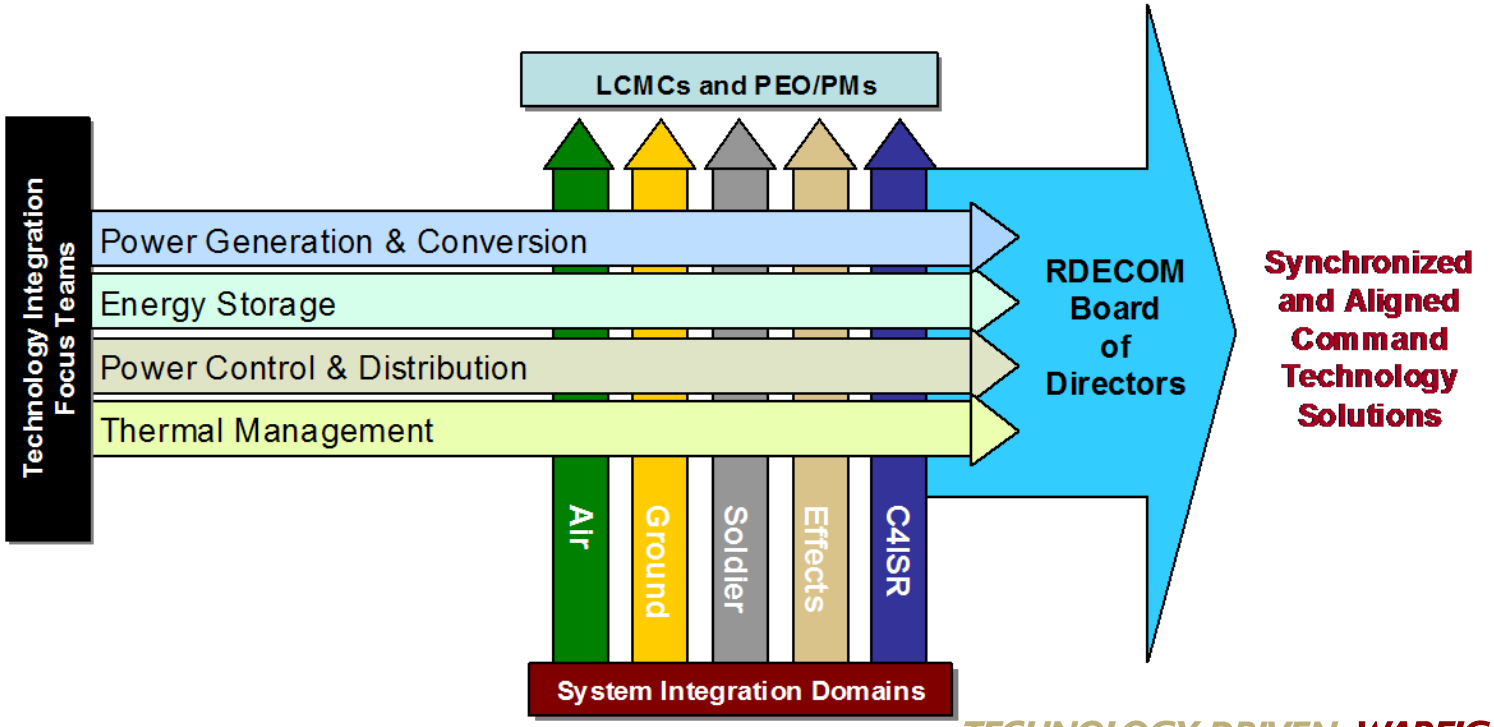
GVPM - Organizational Thrust Areas





TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Magneto-Rheological (MR) Fluid Semiactive Suspension

Purpose:

The MR Fluid Suspension technology provides a means of actively controlling the damping portion of the suspension. The MR suspension accomplishes this control by altering the sheer strength of the MR fluid through a computer controlled magnetic field resulting in optimal ride quality and stability. The MR Suspension technology is low risk and will provide outstanding vehicle performance.

Payoff:

- Improves ride quality
- Reduces shock and vibration
- Improves vehicle mobility/reliability
- Enhances Force Effectiveness, Survivability, and Operational Effectiveness by reducing risk to the War Fighter.
- Reduces crew fatigue (increased crew sustainment)
- Improves crew safety in all operational modes.

Schedule:

- Stryker Baseline Performance Test at YPG - July 2009
- Stryker Simulated Endurance Test at TARDEC – Nov 2009
- Stryker Modernization (S-MOD) Vehicle Demo – April 2010

Deliverables:

The MR Fluid Semiactive Suspension System will be transitioned to PM HBCT for the Stryker Modernization (S-MOD) program at a TRL-8 during Milestone B.

Engine Optimization

Purpose

Develop and demonstrate a fuel efficient, low heat rejecting prototype engine based on an on-road commercial-off-the-shelf diesel engine that is compatible and thus reliable and durable with military fuels (Jet A, JP-5, JP-8 and high sulfur DF-2). Engines do not have to conform to US emissions standards beyond the 1998 model year for on-highway diesel engines.

Develop necessary hardware and/or engine control strategies to allow for reliable and durable use of JP-8 fuel in current heavy-duty, on-road, commercial-off-the-shelf diesel engine high pressure common rail pumps without the use of lubricity additives or additive devices.

Payoff

- Peak Thermal Efficiency of 48% or greater on JP-8 fuel, resulting in decreased fuel consumption
- 20% or greater reduction in Heat Rejection, effectively reducing the cooling system
- Improved durability, reliability and fuel delivery performance on an advanced high pressure common rail fuel system with JP-8 fuel

Schedule

Feb 2010 Completion
- 2 Optimized engines

March 2010 Completion
- 1 Optimized engine
- JP-8 Analysis on High Pressure Common Rail Fuel System

4QFY10 – 2QFY11 Completion
- BAA Topic #15

Deliverables

- One Optimized I6 8.9L 425hp diesel engine, 50 hr NATO Durability Test on JP-8, TRL 6
- Two Optimized I6 13L 520 hp diesel engines, 50 hr NATO Durability Test on JP-8, TRL 6
- Final High Pressure Common Rail Fuel System performance analysis on JP-8 fuel for 1000 hours
- One to Four Optimized diesel engines (225 – 400 hp) under the current TARDEC BAA Topic #15, TRL 6

Dual-Voltage Integrated Starter Generator Development Summary

OBJECTIVE

- ***Design, build, and test a Dual-Voltage Integrated Starter Generator (2V-ISG) and Power Converter Unit (PCU) capable of meeting current and future tactical wheeled vehicle onboard and export power demands.***
- ***The 2V-ISG is expected to contribute to a reduction in space, weight, complexity, and cost of the associated power electronics required for power conditioning for ISG systems.***

DESIGN TARGETS

- ***Sized for SAE #3 bell housing, <=7" axial length***
- ***28VDC: 25 kW (threshold) / 30 kW (objective)***
  - ***Engine cranking / battery charging / low-voltage onboard and export power / regenerative braking / torque boost (parallel hybrid capability)***
- ***270VDC: 35 kW (threshold) / 40 kW (objective)***
  - ***High-voltage onboard and export power***
- ***Cooling: 75 C (threshold) / 100 C (objective)***

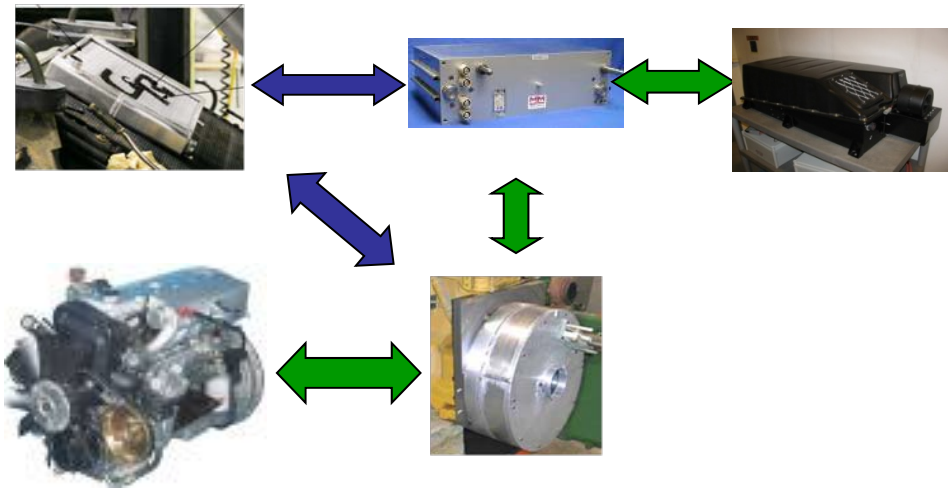
PROJECT SCHEDULE

MILESTONES	FY09	FY10	FY11
Concept Evaluation and System Specification			
2V-ISG Design and Build			
2V-ISG Verification Testing			
PCU Design and Build			
PCU Verification and System Validation Testing			

4 5 6

Project only Funded in FY09

2V-ISG SYSTEM



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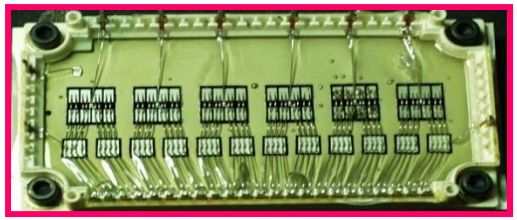
Silicon Carbide (SiC) Power Electronics

BENEFITS:

- Reduced cooling burden resulting in reduced cooling system size and power demand and improved vehicle hybrid propulsion system efficiency
- Reduced size and weight of hybrid electric Components and improved integration into vehicle platforms
- Synergy with high auxiliary loads such as EM Armor EM Gun, and DEW



Advanced SiC Diodes

150 kW SiC dc-dc Converter

ONGOING SiC PROGRAMS:

▪TARDEC/ARL High Temp. SiC Power Electronics:

- 100 ^{0}C All-SiC Transistor Power Modules with (est.) 30% lower power losses than conventional Silicon "IGBT" Power Modules
- Reliable high temperature capacitors and inductors

▪ Wheeled Vehicle Power and Mobility ATO:

- 180 kW Battery-to-Bus DC-DC Converter with 97% efficiency at full power & 100 ^{0}C coolant capable
- Solid State Circuit Breaker: fast response provides more effective fault protection than mechanical breakers, 100 ^{0}C coolant capable.

NEW FY09 PROGRAM:

▪ Financial Stimulus BAA Power Converters:

High Temperature, high frequency Silicon Carbide Power Electronics and Adv. Thermal Management system suitable for Army hybrid electric vehicles and onboard electric power conversion.

Includes:

- 180 kW battery-to-bus DC-DC converter
- 30 kW dc-dc converter to supply 28 VDC
- 30 kW Inverter to supply AC Power
- 50 kW Motor Drive Inverter

Note: All components will operate with a coolant inlet temp. of 100 ^{0} C.

Advanced Lead Acid Battery Technology

PURPOSE:

Improve lead-acid battery technology by replacing conventional lead metal grids with a carbon graphite foam for reduced weight of batteries for military applications. Improvements will be made to first generation 3D battery to develop a next generation $3D^2$ battery for even further weight reduction.

PAYOFF:

- Reduced size and weight, while maintaining the performance of conventional lead-acid batteries.
- Advancement of potential dual-use (commercial & military) lead-acid technology

DELIVERABLES:

- Fifteen 6T format 3D cells
- Three prototype 2V $3D^2$ cells
- Six multi-celled prototype batteries
- Ten application specific prototype packs

Conventional lead-acid vs. advanced lead-acid

- **Objective:** Evaluate advanced PB battery technology which replaces the lead metal grid used in conventional PB batteries with a carbon-graphite microfoam grid for lighter weight.
- **Advantages:** Significant size and weight reduction (~ 50%) while maintaining current performance
- **Status:**
  - Advanced Commercial Group 31 batteries are currently being tested for use in support vehicles and the MRAP.
  - 6T format batteries utilizing this technology are being evaluated for a lightweight replacement for today's Hawker.
  - Progress being made toward further development of this technology. Further testing to follow starting in June 09.

Energy Storage Current Fleet Efforts

Qualify Alternative 6T "VRLA" Battery Suppliers

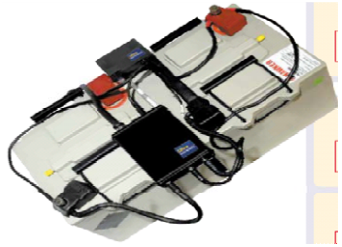
- **Objective: Q**ualify additional 6T case size Valve Regulated Lead Acid (VRLA) battery suppliers.
- **Advantages:** To reduce cost and increase availability of military batteries .
- **Status:**
  - FIAMM has qualified as a second source for their battery produced in Italy
  - Exide is improving their battery technology to qualify as a third source
  - Various other companies have begun development as potential future suppliers

VRLA Battery 2HN Format

- **Objective:** Develop 2HN sized VRLA batteries for use in the Bradley turret, electric generators, etc.
- **Advantages:**
  - Electrolyte filling by field user eliminated.
  - Extended life.
- **Status:** CRADA with C&D signed. Testing to begin May 09.

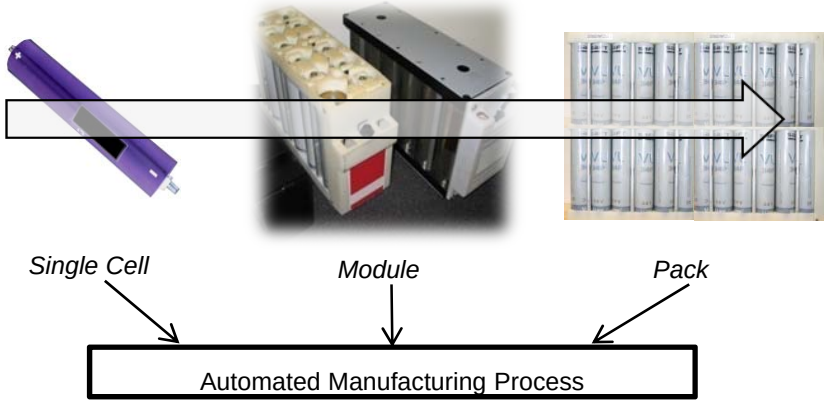
Battery Monitoring System for Lead- Acid Batteries

- **Objective:** Develop an electronic system that would monitor the state of charge & health of a lead-acid battery
- **Advantages:**
  - Indicate the need for battery replacement before it becomes critical.
  - Indicate to user the battery state of charge to maximize silent watch capability and how much the motor pool needs to charge the battery for the next day.
- **Status:** Early stages of development with the support of PM Stryker and Abrams



Battery Management System

High Power, High Energy Density Li-ion Battery Manufacturing



PURPOSE:

- **Improve the current limited manufacturing capability of the Li-Ion battery cells**
- **Provide affordable Li-Ion battery pack for future and current Ground Vehicle Programs**

PRODUCTS:

1. ATO-M

- **Automated manufacturing process for Li-Ion batteries limited in US**
- **Affordable high power and high energy density batteries**

2. ATO-D

- **Increased Power density**
- **Increased Energy density**

PAYOFF:

- Boost power for faster dash and increased survivability
- Extended Silent Watch
- Silent Mobility

Advanced Lithium Iron Phosphate Battery System for Army Combat Hybrid HMMWV & Other Army Vehicle Platforms

PURPOSE:

Advance the Lithium-Iron-Phosphate chemistry for use in hybrid-electric-vehicle and silent-watch applications—including increasing rate capability, extending cycle life, increasing temperature operating ranges, and improving safety—through the use of nanotechnology and fundamental materials research.

PAYOFF:

- Increased rate capability, extended cycle life, increased temperature operating ranges, and improved safety
- Extended Silent-Watch Times
- Advancement of potential dual-use (commercial & military) cell technology

Month 6	Month 8	Month 10	Month 12
Thermal Model for LFP Pack	▪ Sub-Scale LFP Cells ▪ 50-V LFP Module	Preliminary Pack Design	▪ Final Pack Design ▪ Large-Format LFP cells ▪ 50-V LFP modules ▪ 28-V LFP Two-6T pack ▪ Large-Format HI-Temp Cells ▪ High-Power LFP Modules

DELIVERABLES:

- Ten Sub-Scale LFP Cells (8 months)
- Ten Large-Format Cells (12 months)
- One 50-V LFP module (8 months)
- One 28-V LFP Two-6T-Size pack (12 months)
- Anode/Cathode/Electrolyte Materials Research for High-Temp/Low-Temp Operation
- Ten Large-Formant Cells with Increased Temperature Operating Range (12 months)
- Three High-Power modules (12 months)

Ultra Capacitor For HMMWV Efforts

Ultra capacitor for HMMWV

- **Objective:** To use an ultra capacitor in parallel with a vehicle battery for assisted starting, lighting, and ignition to achieve extended battery life.
- **Advantages:** Minimize the voltage sag and improving the life of the vehicle battery
- **Status:** Currently under test for use in the HMMWV at TARDEC

Advanced Heat Exchangers

PURPOSE:

Advance the heat exchanger core design for use in cooling Army ground vehicles power pack & auxiliary, APU, mission equipment and power electronics -- including increasing heat transfer capability, reducing the size of the cooling system space claim, and reducing the weight – through the use of micro tube manufacturing and a unique heat exchanger core design of tightly packed micro tubes.

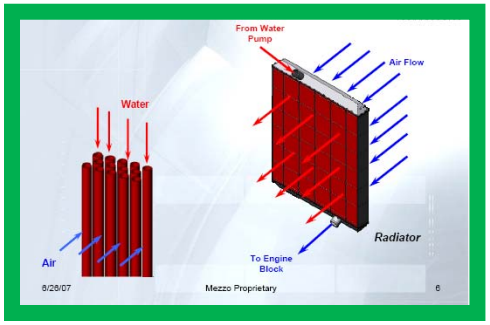
PAYOFF:

- Increased Vehicle Capability at High Temperatures.
- Reduction of Thermal Space Claim.
- Weight Savings.
- Flexible Form Factor.
- Improved Thermal Management System.

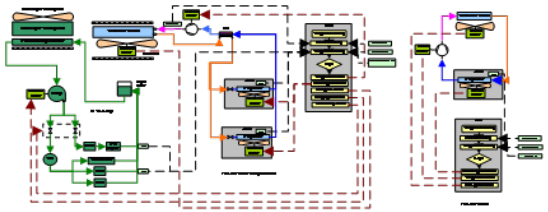
Month 6	Month 8	Month 10	Month 12
Design & Build of HX	Filtration Testing	Perf. Testing	Env. Testing TRL 6

DELIVERABLES:

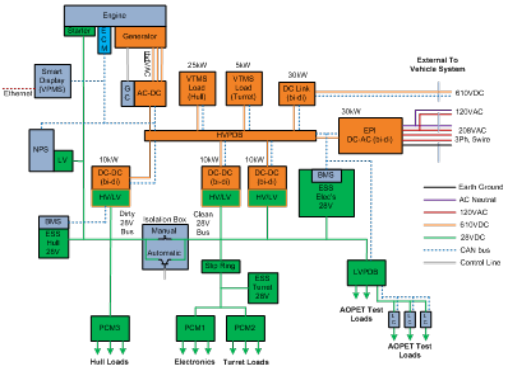
- Full Scale Prototype Micro Tube Heat Exchanger. (6 month)
- Filtration Test Report (8 month)
- Performance Test Report. (10 month)
- Environmental Test Report. (12 month)
- Vehicle Testing BFVS Summer 2010



Advanced On-Board Power, Energy and Thermal [AOPET]



Thermal Management



Power Management

PURPOSE:

Demonstrate advanced technologies in the area of power generation, energy storage, power and thermal management as a complete system on to a vehicle platform.

PAYOFF:

- **Integrated solution of research technologies onto a vehicle and make them work together in a unified manor. Reduce risk to existing modernization programs and provide validated requirements, design to hardware solutions. Effectively increasing their TRL and moving their benefits one step closer to fielding.**
- **Results in a physical prototype vehicle that acts as a transition platform for new technologies.**

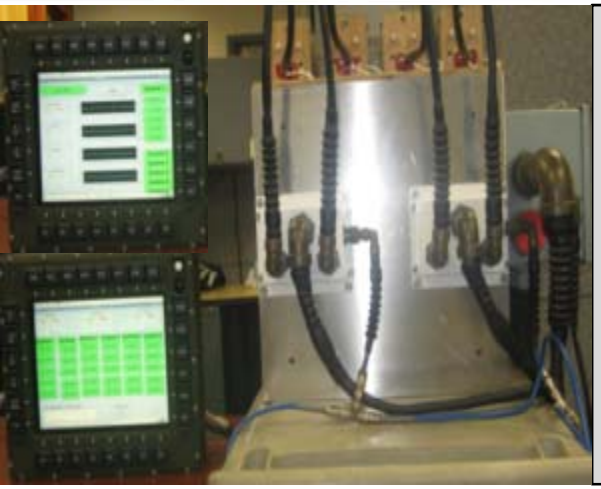
SCHEDULE:

- FY11 ATO completion TRL 6
- FY10 months to component TRL 3-5

DELIVERABLES:

- **Validated system architecture.**
- **Components to subsystem spec for power management, thermal management, energy storage, APU, battery management.**
- **Bradley demonstration vehicle with integrated vehicle power management system (VPMS), non-primary power system (NPS), ESS w/ BMS, and thermal management system.**
- **Modeling library of components, simulated integration of systems onto an Abrams platform.**

MRAP Block I Power Management



PURPOSE:

Demonstrate advanced technologies in the area of power management on to an existing vehicle platform.

PAYOFF:

- **Reduced power draw, enhanced vehicle situation awareness for electrical loads.**
- **State and mode based power management scheme.**
- **Power Management API conformant power management application**

SCHEDULE:

- FY09 TRL 6
- FY10 TRL 8

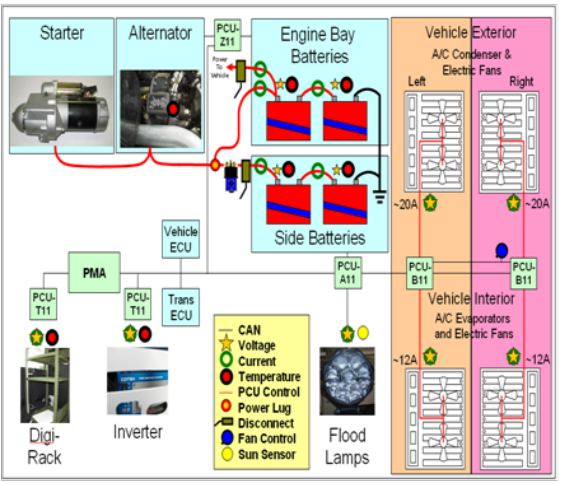
DELIVERABLES:

Power Management Software conformant to PM API

Power Controller hardware supporting current, voltage, and temperature sense and trip points.

Power Management and Point of Load

FMTV,RG31



PURPOSE:

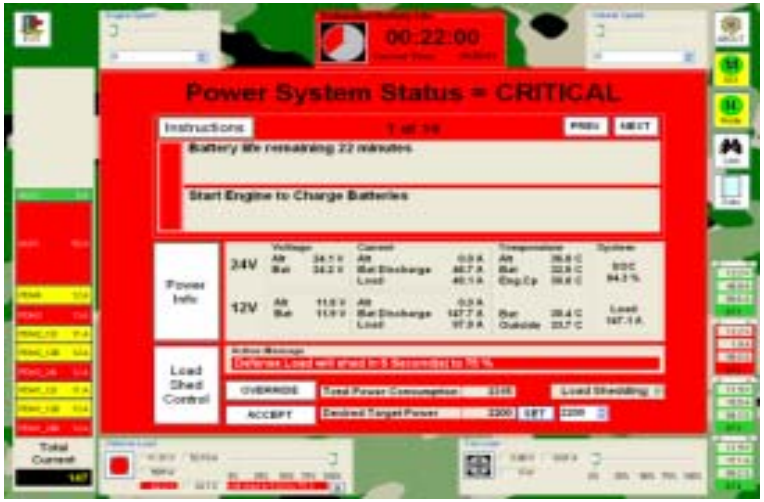
Demonstrate power management technology and conditioned based maintance on the ARMY's tactical fleet.

PAYOFF:

- **Power management system control loads, reduces power consumption, tailor-able situational awareness.**
- **Reduced Logistics burden with preventative measures**

SCHEDULE:

FY09 TRL 5+
FY10 TRL6



DELIVERABLES:

Power management software

Point of load power controller hardware

Final report, lessons learned

Integration report on FMTV, RG31 route clearance vehicle

Test Capabilities and Facilities

- **Propulsion Test Laboratory (Bldg 212):**
  - **10 Test Cells which include:**
    - **6 “engine” test cells used for performance, endurance, transmission or drive train testing**
    - **3 vehicle test cells designed for steady-state tests to 44000 ft-lbs per side as well as transient tests and a Power & Inertia Simulator (PAISI)**
    - **Most contain portable dynamometers with absorption capability of 100-3000 horsepower**
    - **All Test Cells can simulate desert heat, wind and solar conditions at full load**
    - **Test Cell 9**
      - **Ambient temperature control to 160°F**
      - **Wind speeds up to 20mph in eight possible directions**
      - **Two 2500 Hp dynamometers**
    - **Test Cell 10 can test batteries, power electronics and motors to 6000rpm**

- **Air Flow/Cooling Lab (Bldg 7) has air cleaner and radiator testing capability**
- **Track and Suspension Laboratory (Bldg 215)**
- **Power Management System Integration Laboratory (SIL) (Bldg 200)**

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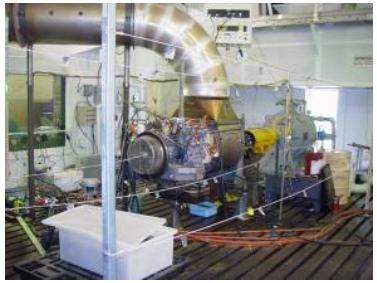
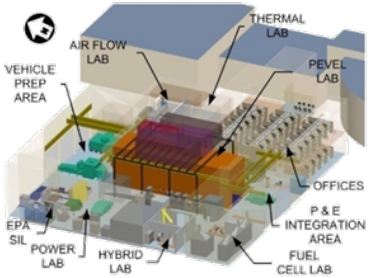


Engine Testing

Power Management SIL



P&E Expansion

Vehicle Testing

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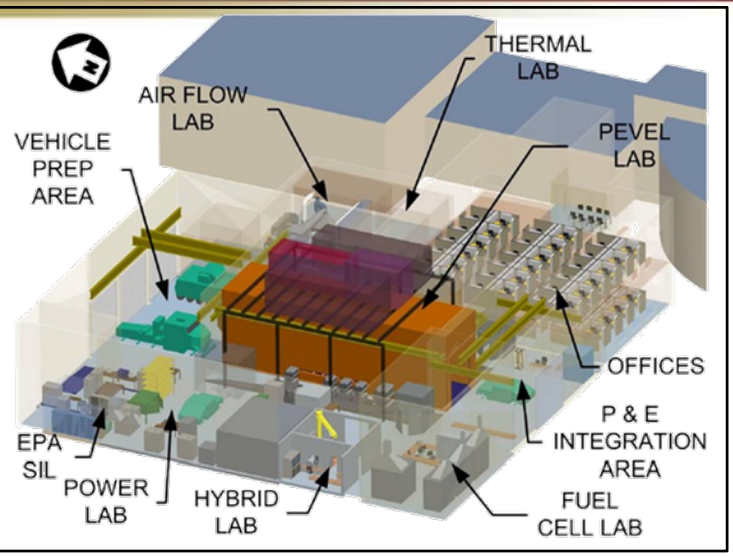
New Ground Systems Power and Energy Lab (GSPEL)



Ground Systems Power and Energy Laboratory (GSPEL)

Provides a facility with the capability to effectively test, optimize and integrate all current and alternative vehicle propulsion, power generation, energy storage, power management and control systems prevalent in all current and emerging classes of vehicles, wheeled and tracked, manned and unmanned

PROJECT COMPLETED 3rd Quarter 2011

- PEVEL Lab provides a mission profile testing capability for every vehicle platform manned or unmanned
- Expands the Army's development of hybrid electric propulsion systems and fuel cell technology

New Energy Systems Laboratory

- Upgraded Electrical Components Lab with 350 kW AC dyno and load bank to include SiC/Silicon power electronics testing capability
- New hydrogen/JP-8 reformation Fuel Cell Lab for battlefield fuel reformation and 10-60 kW silent watch fuel cell RDT&E
- New capability to test and integrate high voltage/frequency chargers, high energy density capacitors, high current solid state switches and dc-dc converters into Pulse Forming Networks for vehicle application
- Relocated and upgraded SIL capability for efficient electrical power distribution and control strategy and architecture development, characterization, integration and test
- Relocated and upgraded Electrochemical (Battery) Power Lab to safely test/evaluate 10-60 kW advanced chemistry battery packs

New Airflow and Thermal Fluids Laboratory

- Relocated and 8X Upgraded flow rate Air Filtration Lab for all vehicles, fully automated, to include self-cleaning scavenge systems
- Relocated and 3X Upgraded flow rate radiator testing capability
- New calorimeter and Thermal Fluids Lab for all vehicle thermal management (cooling) systems including power electronics

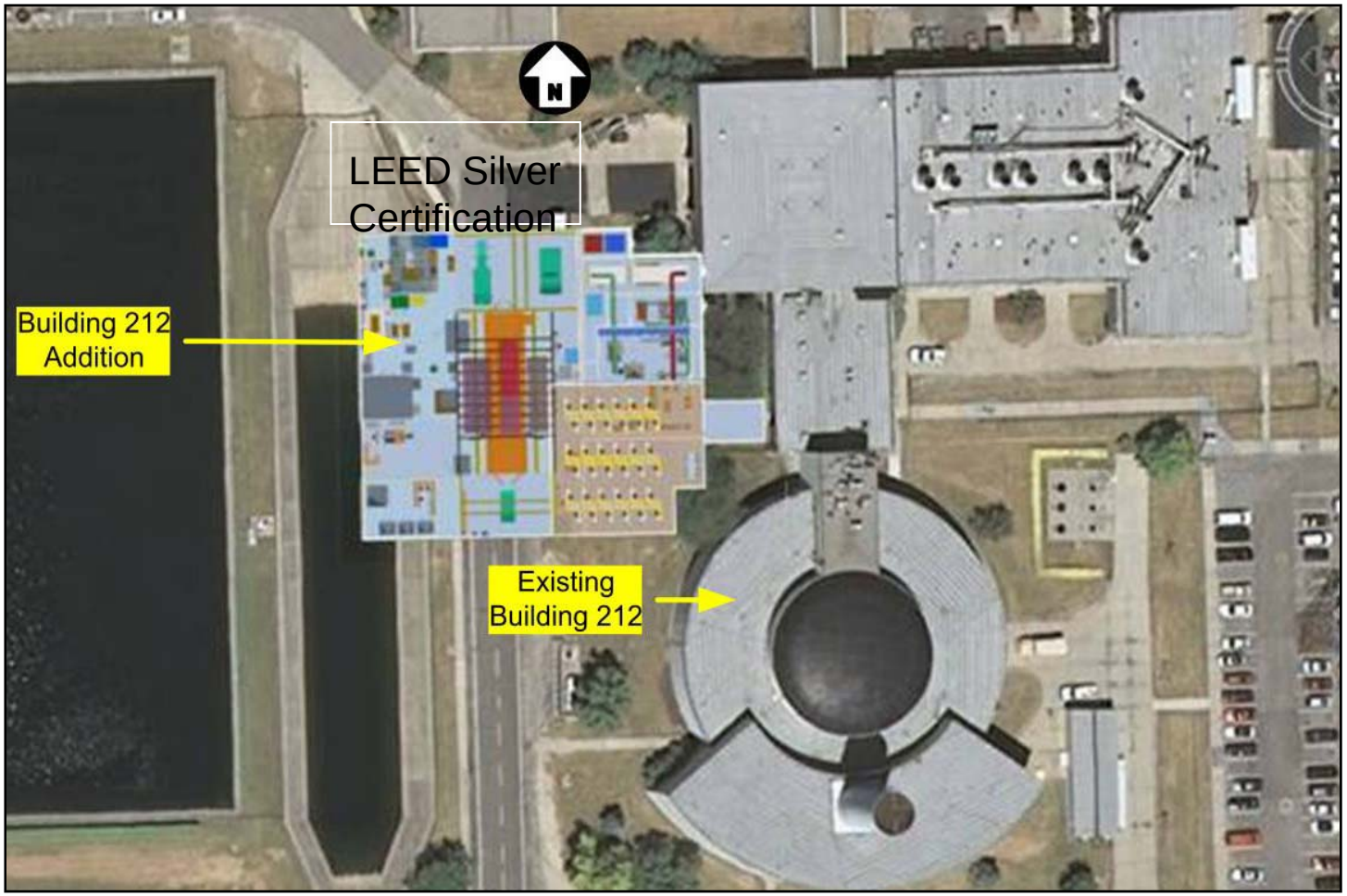
New P&E Vehicle Environmental Laboratory (PEVEL)

New Vehicle Environmental Laboratory
- 12 AC Dynamometers (2 for BFVS class combat vehicle and 10 for all tactical/wheeled vehicle torque/speed ratings)
- Environmental capability from -60 ^{0} F to +160 ^{0} F with variable wind, solar (desert) and humidity (global) control
- Transient cycle (mission profile) test capability for repeatable/controlled condition performance characterization, field failure root cause analysis and modeling and simulation validation data

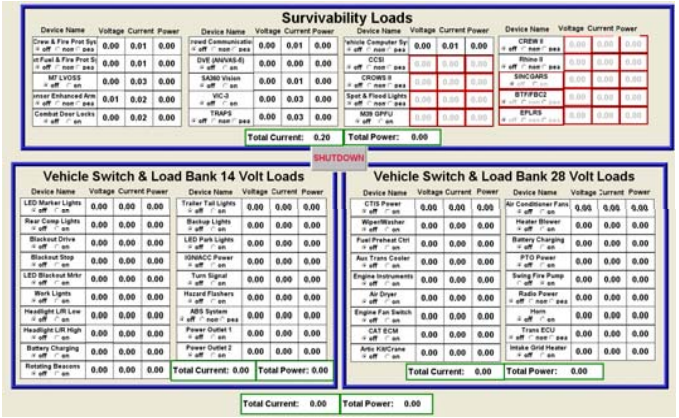
New Electrical Integration Laboratory for subsystem/system level components integration, performance characterization and transient test/evaluation

New Laboratory for network and system level integration of Pulse Power and Direct Energy high voltage/frequency/density/current components performance characterization and transient condition test and evaluation

New GSPEL Footprint



Electronic Power Architecture [EPA] System Integration Lab [SIL]



SCHEDULE:

- Components TRL 4-5
- System 2010 Feb TRL 5

PURPOSE:

Demonstrate advanced technologies in the area of power distribution and power management , as a complete system with realistic configurable vehicle loads. Currently configured as FMTV.

PAYOFF:

- **Integrated solution of research technologies power technologies onto a representative vehicle in a unified manor. Load characterization.**
- **Results in an electrical and data system that acts as a transition platform for new technologies.**

DELIVERABLES:

- **Validated system architecture.**
- **Components to subsystem spec for power management.**
- **Test and validation plan for power controllers**
- **library of simulated integration of electrical systems onto an FMTV platform.**

Advanced Battery Testing

Electrochemical Analysis & Research Lab (EARL) & Bldg 7

Equipment Capability

- Cyclers: 24V-48V
  50A-2000A
  >100 Channels
- Milliohmmeter: portable meter that measures cell impedance.
- Impedance/Gain-Phase Analyzer: Frequency Response and Impedance Analyzer used to characterize conducting materials ranging from highly conducting to highly insulating.
- Power Booster: enables high performance electrochemical tests to be run on a wide range of energy storage devices and electrochemical cells.
- Electrochemical Interface: a high accuracy, wide bandwidth potentiostat/galvanostat (controls voltage or current to maintain constant level in an electrolytic cell) which offers a full range of ac/dc capabilities; when coupled with frequency analyzer.
- Thermal Chambers: $<-37^{o}$C to $>177^{o}$C temperature range.
- Water Baths: Up to 50^{o}C environmental test capability

Elastomer Improvement Laboratory

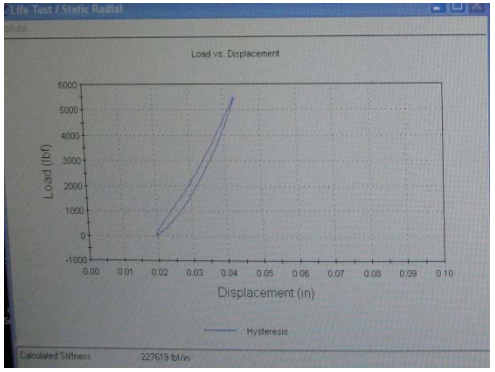
Mission: ***Develop Customized Tests to Identify Failure Modes of Elastomeric Components utilized for Tactical Wheeled Vehicles. Develop, Test and Validate Improved Materials and Designs to Directly Impact the Component Durability and Force Effectiveness of Ground Combat Vehicles.***

Failure Analysis

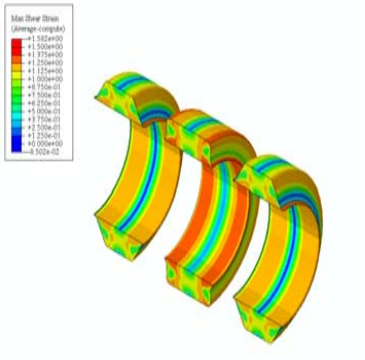
Define Failure Modes – Elastomers, Plastics & Composites
Benchmark Current Materials

Develop Customized Tests

Reproduce Component Failure modes and Screen Improved Materials & Designs



Reengineer Elastomeric Components



Develop Finite Element Analysis (FEA) Models to Predict Design Improvements for Improved Durability

Reformulate/Redesign Improved Bushings, Seals, Motor Mounts ,Grommets ETC.

Study/Define Optimized Polymer Structure

BACKUP

Advanced Battery Testing Performed

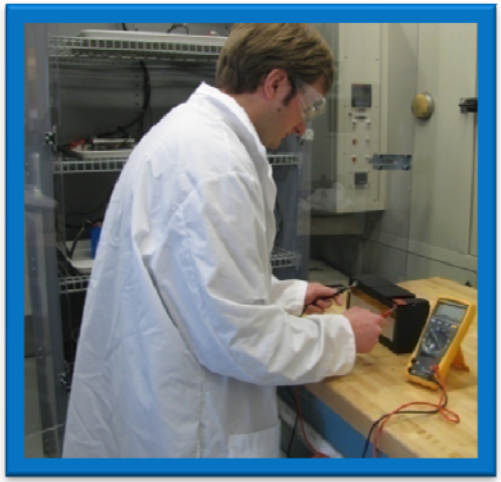
Electrochemical Analysis & Research Lab (EARL) & Bldg 7

Tests Performed

- Incoming Test: Verify that the battery is stable and to determine if limits or conditions in subsequent tests need to be modified.
- Discharge Characterization: Quantify discharge capacity as a function of voltage and time at various current, power discharge levels, and temperatures.
- HPPC (Hybrid Power Pulse Characterization): Provide insight into using voltage as a predictor of capacity and, resistance to predict power during high current discharges.
- Charge to Voltage: Determine the maximum capacity inputted for a given constant current charge to a voltage limit.
- Stand Test: Show how self-discharge will vary with increasing stand times.
- Impedance/Resistance: Measure cell impedance, resistance, and voltage values over a discharge step. This data will baseline cells/battery and can be used for modeling purposes and power calculations.
- Equalization Charge: Monitor cell voltages on charge to verify BMS capability to equalize cell voltages.

Advanced Battery Materials Development

(Army Research Laboratory)



PURPOSE:

Development and use of novel and advanced materials for lithium ion battery cathodes, separators, and electrolytes. This effort shall also access the manufacturability of the improved designs using the new materials.

PAYOFF:

- Improved lithium ion battery power density
- Improved lithium ion battery energy density
- Improved safety of Li-ion batteries in wide-operation temperatures for ground-vehicle and robotic applications

RESEARCH TASKS:

- *Materials Development*
  - Develop electrolytes with faster kinetics at low temperatures and electrolytes to be stable at high temperature
    Develop high-voltage cathode materials to increase energy density and identify promising solvents for improved high-voltage cathode stability through synthesis and evaluation.
- *Cell Development*

Develop and test the 18650 or D-size industrial prototype cylindrical cells incorporating developed high-voltage cathode and electrolytes

Battery Aging Phenomenon

PURPOSE:

Understand the lithium plating of metallic lithium on the graphite negative electrodes in lithium-ion batteries.

PAYOFF:

- Better understanding of lithium-ion battery charging limitations
- Improved safety for battery application
- Better battery designs

TASKS OF YEAR 2009:

- Extraction of synthetic aging duty cycles from real driving data of Li-ion and lead-acid batteries
- Development of specific aging and assessment plans to be performed with CAR laboratory equipment
- Data analysis for:
  - Theoretical evaluation of the batteries state of health behavior due to the aging factors (current, SOC, temperature)
  - Development of diagnostic and prognostic algorithms to determine the calendar life and remaining capacity of batteries

TASKS OF YEAR 2010:

- Increase the number of dedicated automatic test benches
- Continue the aging activity, the analysis and the extraction of relevant electro/thermal duty cycles based on real life data
- Continue the development and the implementation of an aging battery simulator to track changes in the battery system and design prognostic algorithms
- Preliminary validation of the prognostic algorithm

Large-Format Lithium – Ion Cell Development

PURPOSE:

Develop a large-format, 10-Ah, cylindrical Lithium-Iron-Phosphate cell for use in hybrid-electric-vehicle and silent-watch applications

PAYOFF:

- Increased Reliability & Safety
- Reduced Interconnects Between Cells in a Module
- Extended Silent-Watch Times

DELIVERABLES:

- Generation 1 cells demonstrating cathode energy density improvements
- Generation 2 cells demonstrating cathode energy density and production improvements

Lithium Plating Phenomenon

PURPOSE:

Understand the plating of metallic lithium on graphite negative electrodes in lithium ion batteries.

PAYOFF:

- Ability to charge at the maximum safe rate
- Improved Safety for battery application
- Better battery design

RESEARCH TASKS:

- In-situ measurement of the Li chemical environment
  - Li chemical environment during plating
  - Determining the relative lithium nucleation and growth rates
- Measuring Lithium ion transport coefficients
  - Measure inter-particle transport rates
  - Measure intra-particle transport rates
  - Determine maximum allowable charging rate
- Experimental determination of 3-dimensional structure of anode electrode to better understand transport

Mechanism of Battery Thermal Runaway

PURPOSE:

Understand the thermal runaway phenomenon within VRLA lead-acid batteries and find proper ways to suppress it.

PAYOFF:

- Better understanding of the VRLA lead-acid battery thermal runaway phenomenon
- Improved Safety for VRLA lead-acid battery applications
- Better battery designs

RESEARCH TASKS:

- Investigate the heat contribution from anode and cathode and propose a theoretical thermal model
- Study the impact of saturation on battery thermal and electrical characteristics
- Measure current-voltage characteristics and determine maximum cell voltage
- Determine preferred separator type and thickness, as well as optimum electrolyte concentration and saturation

Aqueous, Asymmetric Ultracapacitor Power & Capacitance Optimization

PURPOSE:

Develop a 24-V, aqueous, asymmetric ultracapacitor with the power and capacitance necessary for military vehicle engine starting and energy capture.

PAYOFF:

- Improved cold weather vehicle starting capability
- Extended battery lifetimes in high temperature environments
- Longer Silent Watch operation
- Greater efficiency energy capture from regenerative braking in hybrid-electric vehicles

FEATURES:

- Packaged in a 6T battery case for drop-in replacement format
- High Cycle Life (>100,000 cycles)
- Half the weight of lead-acid batteries
- Wider operating temperature range
- Higher power density (more cranking amps)

DELIVERABLES:

- Two prototype ultracapacitor modules for testing

Testing of Nickel Zinc Cells and Batteries

PURPOSE:

The proposed work intends to corroborate that NiZn cells and batteries from SCPS have the extended cycle lives and the claimed low costs.

PAYOFF:

- Inherently safer than lithium based batteries
- Employ aqueous electrolytes vs. flammable organic electrolytes in Li Ion cells/batteries
- Has potential to be considerably lower in cost than Li Ion (closest to advanced lead acid)
- More energy and power density than Pb Acid, NiMH, or NiCd.

DELIVERABLES:

- Ten 30-Ah 'energy' cells (Phase 1)
- Two 6-V, 30-Ah 'energy' batteries and then fabricate/deliver 'power' battery' (Phase 2)
- One 50-V, 30-Ah 'energy' battery (Phase 3)

- Multiple single cells for evaluation

Prototype Modules

PURPOSE:

- Perform characterization tests on Lithium-Iron-Phosphate and Lithium-Manganese cells and modules to assess their suitability for ground vehicle applications
- Assess the safety characteristics of Lithium-Ion cells

PAYOFF:

- Build TARDEC's knowledge of Lithium-Ion technologies and knowledge of the Li-Ion marketplace
- Development of two prototype modules based on production modules and designed for lab testing

DELIVERABLES:

- One Lithium-Iron-Phosphate Module
- One Lithium-Manganese Module

Abrams Silent Watch Battery

PURPOSE:

Enersys has developed the ARM100 lithium-ion battery for silent watch power in the Abrams tank. They are intended to replace the VRLA batteries currently being used. TARDEC will do an initial test and evaluation of the prototype batteries from Enersys to understand the capabilities and limitations of this system for the intended application.

PAYOFF:

- Lighter weight, longer run times than the current lead acid batteries
- Greater cycle life than the current lead acid batteries
- Can operate in combination with existing vehicle batteries using internal voltage regulator

Testing	Test Report	Final Assessment
2 weeks (remaining)	2 weeks	1 week

DELIVERABLES:

- Test Report covering initial testing
  - Capacity
  - Temperature performance
  - Compatibility with VRLA batteries
  - Charge to voltage
  - Overcurrent / Overvoltage
- Final assessment and recommendations for improvement

Advanced Battery Testing

Electrochemical Analysis & Research Lab (EARL) & Bldg 7

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